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## C-A OPERATIONS PROCEDURES MANUAL

### 7.1.38 RHIC Warm-Up

Text Pages 2 through 8

#### Hand Processed Changes

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Approved: \_\_\_\_\_ *Signature on File* \_\_\_\_\_  
Collider-Accelerator Department Chairman Date

D. Lederle

## **7.1.38 RHIC Warm-Up**

### **1. Purpose**

This procedure provides instructions for the warm-up of the RHIC rings and refrigerator.

### **2. Responsibilities**

- 2.1 The Shift Supervisor, or an Operator designated by the Shift Supervisor, is responsible for conducting the procedure and providing documentation in the Cryogenic Control Room Log.
- 2.2 Should a problem arise during the completion of this procedure, the Shift Supervisor shall contact the Technical Supervisor for instructions before continuing.

### **3. Overview**

- 3.1 The blue ring will be kept cold as yellow is warmed up. The yellow ring JT valves will be shut and the circulator will be shut down. The M and S lines will be made common. As the ring warms, cold gas will be forced back through the supply line and will be used to liquefy at the LSA. H86A will be at its normal setpoint initially, then will be set to match the pressure of the VJRR S line to maintain some flow through H86A. This will keep the blue ring cold. This will continue until the ring gas can no longer be used to liquefy, at which time the ring gas will be routed back to compressor return through the appropriate CR bypass, or the thermax heaters. Liquid production will continue via refrigerator and by repeating the process for the blue ring.

### **4. Prerequisites**

- 4.1 Reduce helium inventory as shutdown nears. Leave 1 – 4 tanks on at 8 atm with the rest at 1.3 atm, all three liquid helium dewars at low levels and cold.
- 4.2 Thermax heater and refrigerator cold end calorimeter should be available.
- 4.3 Align at least 25 warm gas tanks for pump back.
- 4.4 Magnet warmup heaters are ready for use.

### **5. Precautions**

- 5.1 This procedure provides general guidelines for the RHIC warm-up. The steps in this procedure may vary depending on the operational requirements at the time of warm-up, i.e. schedule, testing, equipment problems, etc.

## 6. **RHIC Warm-up Procedure**

### **Yellow Ring**

1. Commence making liquid into LSA using normal methods.
2. Set cold end calorimeter between 0 and 2 kW initially and adjust flow through H173A to balance refrigerator.
3. Stop circulator in the yellow ring.
4. Close all yellow ring JT valves (page D285).
5. Make M and S lines common. Open H6730A at 6:00 yellow valve box.
6. Leave lead flows as is initially.
7. Set H1100A to manual and closed.
8. Ring will begin to warm up, forcing cold gas back through supply line, increasing pressure in supply line. H86A will begin to close. Adjust H86A set point as necessary to maintain some flow. Increase calorimeter power, and flow through H173A as necessary to balance the refrigerator.
9. Liquid production into LSA will continue with most of the gas being supplied from the warming ring, and very little being supplied from the refrigerator through H86A. JT flow rate should be approximately 200 g/s.
10. Increase the rate of liquid production as necessary to control supply line pressure at 5 atm.
11. If necessary, vent excess gas to CR line by opening H6737A and throttling open H6706A. Monitor compressor inlet temperature and use thermax heaters if necessary.
12. Precool the R-line from the LSA to accept boil off from LSA.  
  
At LSA open H9704A. Slowly open H 4505A. Monitor return temperature at cold end of refrigerator (TI106). Temperature should not rise more than .25 K. When H4505A is fully open, slowly close H4525A, keeping same temperature constraint. If R-line pressure is higher than CR pressure, it may be possible to precool by flowing backward through H4505A, H9704A and H4525A to CR line.
13. Continue liquid production as long as possible based on supply pressure and temperature at the LSA.

14. Monitor H86A flow, and make up valve H3031A position, to ensure that most of the cold helium supply to the LSA is coming from the warming ring and not the tank farm/refrigerator. Adjust JT valve flow rate, and/or adjust H86A pressure set point as necessary.
15. If JT flow rate into the LSA is under 200 g/s after 2 hours have elapsed since isolating the ring, consider isolating the yellow ring heat shield as described in step 18 below.
16. If conditions are stable after 4 hours of liquefying into the LSA from the yellow ring, consider starting the blue ring procedure (step 27 below) and work in parallel with the remaining steps of this yellow procedure.
17. When the ring temperature/pressure can no longer be used to produce liquid at the LSA, or the Blue ring cannot be maintained, isolate the ring from the supply line. Close H6607A, H6601A, H6701A. Verify H6605A shut. Send the gas from the yellow ring back to compressor return through the appropriate bypass. (6Y)Open H6737A, use H6706A to control pressure in ring at approximately 3 atmospheres.
18. Continue liquid production at the LSA via the refrigerator and tank farm.
19. Isolate the ring heat shield at 6:00 Valve box. At 6:00 Y valve box: slowly close H6702A. Verify H6610A is closed. At refrigerator, adjust H9A to maintain proper flow through the other ring's heat shield. Close H6602A after the heat shield pressure has bled down.
20. When the ring pressure is at 3 atm., begin using magnet heaters to control warm up and the amount of gas coming back. Start with 1% power input. Magnet temperatures must not exceed 300K.
21. Monitor O2 and N2 levels as ring warms. Switch tanks as O2 level goes up, based on temperature. Separate tanks into three groups: <80K, 80-250K, above 250K.
22. When ring temperature is approximately equal to heat shield temperature, slowly equalize pressures between Heat Shield and M and S lines: Keep heat shield and M and S lines common.
23. When ring temperatures are at approximately 100K, use utility compressor to circulate gas around the ring. Align the utility compressor to take suction from the ring through the thermax heaters and PR line, and discharge through the purifier and out to the ring through the WS line. At compressor room: Open H3013M, H3044A, H3045A, H3037M, H3063M. H3032M, Verify shut H3009M, H3230A, H3068A, H3039A, H3043A, H3008M. Manipulate valves as required at 6:00 Y valve box to force gas around the ring and back to the CR line.

24. When Magnet temperatures approach 250 K on average, start to warm the S and R lines. AT 6:00 valve box, open H6601A, open H6636A, H6736A.
25. Open J-T valves counter clock-wise around ring starting at sextant 4/5. As temperatures warm, progress around ring.
26. Offload liquid helium

### **Blue Ring**

#### **Prerequisites:**

- a. Yellow ring pressure stable with heat shield off.
  - b. The equivalent of at least two Dewars available at the LSA.
  - c. At least 6 tanks available at the tank farm.
27. Stop circulator in the blue ring.
  28. Close all blue ring JT valves (page D285).
  29. Make M and S lines common. Open H4630A at yellow valve box.
  30. Leave lead flows as is initially.
  31. Ring will begin to warm up, forcing cold gas back through supply line, increasing pressure in supply line. H86A will begin to close. Adjust H86A set point as necessary to maintain some flow.
  32. Calorimeter will be needed at this point. Set it to .5 to 3 Kw initially and adjust to balance refrigerator.
  33. Liquid production into LSA will continue with most of the gas being supplied from the warming ring, and very little being supplied from the refrigerator through H86A.
  34. Increase the rate of liquid production as necessary to control supply line pressure.
  35. If necessary, vent excess gas to CR line by opening H4637A and throttling open H4606A. Monitor compressor inlet temperature and use thermax heaters if necessary.
  36. When conditions are stable, close all lead flows in the both rings from the computer, including valve box leads.
  37. Continue liquid production as long as possible based on supply pressure and temperature at the LSA.

38. Monitor H86A flow, and make up valve H3031A position, to ensure that most of the cold helium supply to the LSA is coming from the warming ring and not the tank farm/refrigerator. Adjust JT valve flow rate, and/or adjust H86A pressure setpoint as necessary.
39. When the ring temperature/pressure can no longer be used to produce liquid at the LSA, isolate the ring from the supply line. Close H4524A, H4601A, H4501A. Verify H4558A shut.
40. Continue liquid production at the LSA via the refrigerator and tank farm.
41. Send the gas from the yellow ring back to compressor return through the appropriate bypass. (6Y)Open H4637A, use H4606A to control pressure in ring at approximately 3 atmospheres.
42. Isolate the ring heat shield at 6:00 Valve box. At 6:00 B valve box: Verify H4510A is closed. Throttle open H4645A and throttle closed H4602A to maintain VJRR heatshield flow. First verify shut H6602A at 6:00 yellow to prevent crossconnect between blue and yellow. Isolate H-line at 4:00 blue.
43. Route through purifier when temperature coming from ring increases to 80 K. Open: H1107M, H3049M, H3015M. Close H1103M. Set oxygen monitor to read at purifier inlet.
44. Maintain 50 – 80 g/s flow through the thermax, and keep purifier online at 7 atm or higher. To keep adequate pressure in the purifier, it may be necessary to fully open H4606A at 6:00 Y valve box and control flow through the thermax using valves downstream of the purifier
45. Isolate R-lines at 6:00 when temperatures get too warm for the refrigerator R-line.
46. When ring pressure is at 3 atm., use magnet heaters to control warm up and the amount of gas coming back. Start with 1% power input. Magnet temperatures must not exceed 300K.
47. Monitor O2 and N2 levels as ring warms. Switch tanks as O2 level goes up, based on temperature. Separate tanks into three groups: <80K, 80-250K, above 250K.
48. When ring temperature is approximately equal to heat shield temperature, slowly equalize pressures between Heat Shield and M and S lines: Keep heat shield and M and S lines common.
49. When ring pressure is no longer adequate to maintain the purifier online, use utility compressor to circulate gas around the ring. Align the utility compressor to take a suction from the ring through the thermax heaters and PR line, and discharge through the purifier and out to the ring through the WS line. At

compressor room: Open H3013M, H3044A, H3045A, H3037M, H3063M, H3032M. Verify shut H3009M, H3230A, H3068A, H3039A, H3043A, H3008M. Manipulate valves as required at 6:00 B valve box to force gas around the ring and back to the CR line.

50. Monitor O2 and N2 level as ring warms. Switch tanks as O2 level goes up, based on temperature. Separate tanks into three groups: <80K, 80-250K, above 250K.

51. Off load liquid helium

## **7. Refrigerator Warm-up Procedure**

### **Refrigerator Warm-up**

There will be dirty gas coming back from the rings during the refrigerator warmup, also, any gas taken out of the refrigerator will be considered dirty, and should be put in separate tanks.

### **Prerequisites**

1. Helium Off loaded. Minimal cold gas coming off the rings.
2. At least 15 warm gas tanks are at about 1 atm available for pump back.

### **Procedure**

1. Empty refrigerator liquid Helium pots.
- 2., Close H25A, H9A.
3. Shut off cold end refrigerator calorimeter.
4. Shut off all first stage and second stage compressors except for 1 first stage and one second stage.
5. Align path from blue and yellow H lines back to CR and slowly drain pressure. Drain VJRR heat shield pressure down back through CR via H4602A (6B), H6702A (6Y).
6. Align 10 new tanks for pumpback.
7. Shut off turbines.
8. Secure turbine skids. Shut off turbine oil pumps.
9. Ensure the utility and main compressors have pump back and bypass control.

10. Isolate on-line adsorbers, and turbines. These can sit on relief valves until regenerated.
11. Close all turbine filter inlet and outlet valves.
12. Isolate high pressure side of refrigerator. It will be assumed this gas is dirty and will be vented. Close spider valves, H86A, H100A.
13. Secure the seal gas compressor 30 min after the turbines have been shutdown. Isolate the seal gas reserve tank.
14. Ensure that the ring CR line is separated from the refrigerator CR line:  
Open/check open H849A. Close/check closed H4644A, H5M. Vent any excess pressure in the refrigerator CR line back to normal return through H123A.
15. Warm the LSA dewars by sending warm gas into the dewars and returning through H4505A.
16. When the ring return is warm enough to bypass the thermax and reduce the CR line pressure, open up return of refrigerator to sit on CR line.
  - a. Open H26A, H123A, H238M, H827M, H5M, H58A, H54Am  
H131A, H106A, H114A.
  - b. Close H38A, H90A, H89A
17. Isolate both warm heat exchangers on return side.

**8. Documentation**

None

**9. References**

None

**10. Attachments**

None